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Dr. Günther, N. H. S.

from his friend

the Author.

MONOGRAPH
ON
THE FOSSIL REPTILIA
OF THE
WEALDEN AND PURBECK FORMATIONS.

SUPPLEMENT No. VIII.

PAGES 1—15; PLATES I—VI.

CROCODILIA (GONIOPHOLIS, PETROSUCHUS, AND SUCHOSAURUS).

BY
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ETC. ETC.

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SUPPLEMENT (No. VIII)
TO THE
MONOGRAPH
ON
THE FOSSIL REPTILIA
OF
THE WEALDEN AND PURBECK FORMATIONS.
(GONIOPHOLIS, PETROSUCHUS, AND SUCHOSAURUS.)

ORDER. *CROCODILIA*.

Genus—*GONIOPHOLIS*, *Owen*.¹

Species—*Goniopholis crassidens*.² Plates I—IV.

THE knowledge of this remarkably well-defended Amphicœlian Crocodile has been chiefly derived from a study of the specimen now in the British Museum, obtained in 1837 by ROBERT TROTTER, Esq., F.G.S., from a quarry of Purbeck stone in the vicinity of Swanage.³ Confirmation and additional characters of the genus have been afforded by more fragmentary remains obtained by MANTELL from the Wealden of Tilgate, and by G. B. HOLMES, Esq., from the Wealden of Cuckfield and the vicinity of Horsham.

The first indication of the genus was given by detached teeth, one of which is figured in Plate I, fig. 3, from the Tilgate quarry, and which presented a more robust form of crown than that of *Suchosaurus* and other *Crocodilia*, then known, of that formation; the proportions being rather those of the teeth of the procœlian broad-faced Crocodiles⁴ and Alligators⁵

¹ 'Report of the British Association,' "On British Fossil Reptiles," Part II, 1841, p. 69.

² *Ib.*, *ib.*, p. 69.

³ A reduced view of this group of parts of the same skeleton is given in Mantell's 'Wonders of Geology,' vol. i, pl. i, 3rd edit., 1839. The quarry belongs to the 'Limestone Series' of the 'Middle Purbeck.'

⁴ Cuvier, 'Ossemens Fossiles,' 4to, tome v, part ii, pl. i, figs. 4 and 5.

⁵ *Ib.*, *Ib.*, figs. 6, 7, 8.

of the Tertiary and modern times.¹ The resemblance was carried out by the unequal size of the teeth in the same jaw, as shown by portions of *maxillæ* and *mandibulæ* subsequently acquired. But the Wealden teeth differed in the longitudinal ridges of enamel traversing the exterior of the crown; such ridges being numerous, close-set, and neatly defined. Two of the ridges, longer than the rest, traverse opposite sides of the tooth, about midway between the fore and hind outlines in the side-view. In the larger teeth (Pl. I, fig. 3) they extend from the base to the apex; in the smaller teeth (ib., figs. 4 and 6) these opposite ridges are limited to the apical half of the crown, to which they may give somewhat of a trenchant character. At the back part of the series (ib., fig. 7) the dental crown becomes obtuse, as it is shown to do in a former Monograph (tom. cit.), in *Alligator Hastingsiæ* and *Crocodilus Spenceri*.

On these characters the present genus and species were originally founded,² and the fortunate preservation of two teeth in the lower jaw of the dislocated parts of the skeleton from the Purbeck stone determined its generic, if not specific, affinity with the Wealden type of *Goniopholis crassidens*.

In the notable slab from Swanage the parts which first and more especially attract attention are the numerous, large, bony, dermal plates or scutes. These are scattered irregularly over the slab, and in their number and relative size bring the species much nearer to the extinct Teleosaurs than to any of the existing Crocodiles; they differ, however, from both the dorsal and ventral scutes of the Teleosaur in their more regular quadrilateral figure (Pl. IV, fig. 1); they are longer in proportion to their breadth than most of the Teleosaurian scutes, and are distinguished from those of other Crocodilians, recent and fossil, by the presence of a conical, obtuse process (ib., *a*), continued from one of the angles, transversely to the long axis of the scute: it is analogous to the peg or tooth of a tile, and fits into a depression on the under surface of the opposite angle of the adjoining scute; thus serving to bind together the plates of the imbricated bony armour, and repeating a structure which is characteristic of the large bony and enamelled scales of many extinct Ganoid Fishes. Some of the scutes in the Swanage specimen are 6 inches in length and $2\frac{1}{2}$ inches in breadth; the average length is that shown in the figure.

The exterior surface of the scute is impressed by numerous deep, round, oblong, rarely angular pits, from two to four lines in diameter, and with intervals of about two lines, defined by convex, reticularly disposed ridges of the bone; but a larger proportion of the border of the scute is overlapped by the contiguous scute than in the Teleosaur, and this part (Pl. IV, fig. 1, *c*) is smooth and thinner than the rest of the scute. The whole of the inner surface of the scute (Pl. III, *b*) is smooth; but on

¹ See "Monograph on Reptilia of the London Clay," in the volume of the Palæontographical Society, issued for the year 1849.

² 'Report,' loc. cit.

close inspection it is seen to be everywhere impressed by fine, straight lines, decussating each other at nearly right angles, and indicating the structure of the corium in which the scutes were imbedded. Thus, from the size and strength of these dermal bones, their degree of imbrication, and the structure for interlocking, we may conclude that the *Goniopholis* was better mailed than the *Teleosaur*, which Cuvier regarded as “l'espèce la mieux cuirassée de tout le genre.”¹

In the slab in question the vertebræ were all at right angles to the exposed plane, and fractured across the middle, one extremity being buried in one of the halves of the slab, and the other in the opposite half. By permission of the Trustees of the British Museum, I proceeded, in 1841, to remove the matrix from the two extremities of the same vertebra, and so demonstrated that both articular ends were equally but slightly concave (Pl. II, figs. 8, 9).

	Inches.	Lines.
The length of the body of the vertebra examined was	2	0
Vertical diameter of the articular extremity	1	9
Transverse diameter of the articular extremity	1	8
Ditto of middle of the body	0	11
Ditto of entire vertebra, including the transverse processes	10	0
Height of entire vertebra, including spinous process	4	4
From the lower part of the centrum to the base of the transverse process	2	6

The suture which joins the neural arch to the centrum is conspicuous; it forms an ascending angle or curve at its middle part. In the degree in which the body of the vertebra expands to form the subconcave articular surfaces, in its smooth, non-articular surface, and in the circular transverse contour at the lower part of the centrum, *Goniopholis* resembles *Streptospondylus* more than it does *Teleosaurus*.

The diapophyses of the lumbar and anterior caudal vertebræ are long, straight, and comparatively slender; those of the sacral vertebræ are relatively thicker, and the spaces enclosed by their expanded extremities are smaller than in either the *Teleosaurs* or *Crocodyles*. The antero-posterior extent of the two sacral vertebræ is three inches two lines.

The ilium is broader than in the existing *Crocodylians*; the bifurcation of the proximal end of the ischium is more marked, and the iliac branch is more regularly rounded; the pubic branch is longer, more slender, and its articular end is more regularly convex; the distal or lower part of the ischium expands into a relatively broader plate. This character is still more conspicuous in the pubis, which equals the ischium in breadth, and begins to expand much nearer the proximal extremity than in the existing *Crocodyles*. In these modifications of the pelvis, as well as in the biconcave

¹ ‘Ossements Fossiles,’ tom. v, pt. 2, p. 139.

structure of the vertebræ, the Crocodilian of the Purbeck limestone, like others of the Mesozoic epoch, was probably more marine than existing Crocodilians. The caudal vertebræ were provided with long, narrow, unanchylosed chevron bones.

The portion of the mandible preserved in the Purbeck slab belongs to that part of the left ramus included between the articular extremity, which is broken off, and the hind commencement of the dental series, of which two teeth (Pl. I, fig. 7) remain. This portion of jaw measures 1 foot 6 inches in length, and 5 inches in greatest depth. In these proportions, and the curve of the lower margin, it deviates from the Oolitic Teleosaurs and Steneosaurs, and resembles the modern Crocodiles; and although not quite equalling these in the robust proportions of the jaw, yet it much exceeds in this respect the Crocodilians with more slender teeth.

Portions of the skeleton of a *Goniopholis*, kindly submitted to my examination by G. B. Holmes, Esq., of Horsham, by whom it was discovered in a Wealden stratum at Cuckfield, Sussex, include the fore-part of the premaxillaries (Pl. I, figs. 1 and 2). This shows a semicircular anterior contour, and a single subcircular nostril (fig. 2 *n*), placed rather nearer the termination of the muzzle than in existing Crocodiles; but yet above; not terminal, as in *Teleosaurus*, nor subterminal, as in *Steneosaurus*. There is not enough of the bone preserved to show whether there was a constriction of the upper jaw behind the nostril, as in the Gavial. The incisive foramen is not immediately beneath the nostril, as in the modern and Tertiary Crocodiles. The outer surface of the premaxillaries is convex, rather irregular, with vascular foramina and wrinkled impressions. The margins of the symphysis (*s*) are a little produced. There are four alveoli in each premaxillary, as far as the bone is preserved; they are proportionately larger, more numerous, and closer together than in the corresponding part of the *Streptospondylus* or *Steneosaurus brevirostris*.¹ The first and smallest socket is in contact with the second, which is the largest; the intervals increase beyond this socket (Pl. I, fig. 1). The palatal surface shows a pair of large and deep approximate fossæ, and a second pair of smaller fossæ, apparently for lodging the crowns of the anterior teeth of the lower jaw.

The subject of fig. 5, Pl. I, is from the Purbeck stone, and of a somewhat larger individual than the Cuckfield specimen.

In a mandibular fragment from Cuckfield (Pl. I, fig. 8) the cylindrical fang of a well-preserved tooth is invested by smooth cement; the coronal ridges begin at the basal line of the enamel, and proceed nearly parallel to the apex of the cone. In a tooth with a crown one inch long and half an inch across the base four ridges are included in a space of one line's breadth; a few of the ridges are interrupted to preserve the parallelism of the rest. Towards the apex a number of shorter and finer ridges are present on each side of the two chief ridges, to which they obliquely converge. At the extreme apex of an unworn tooth the ordinary ridges terminate in fine, slightly wavy lines, forming a subreticulate surface.

¹ 'Ossem. Fossiles,' 4to, t. v, pt. 2, pl. x, fig. 6.

In the Jurassic Crocodilian (*Madrimosaurus*, V. Meyer) the coronal ridges of the teeth are more numerous, are smaller at the base of the enamel, and more of the ridges are interrupted than in *Goniopholis*; the entire tooth also seems to be shorter and thicker.

The three vertebræ represented in figs. 1—5, Pl. II, were obtained by Mr. Holmes from the same bed of Wealden clay, at Cuckfield, as the teeth and scutes, figured in Pl. III, characteristic of the genus *Goniopholis*, to which, therefore, I refer them. They correspond with the fourth, fifth, and sixth cervical vertebræ of the recent Crocodile, having a parapophysis (*p*) similar in form, extent, and position, with traces of a short and thick hypapophysis, *hy*, at the fore part of the under surface; but that surface of the Wealden vertebra is less convex, the whole centrum is relatively broader, and the more important difference of the concavity of the hinder as well as of the fore articular end manifests the distinct family of *Crocodylia* to which the *Goniopholis* belongs. The depth of the concavity of these surfaces exceeds that in *Teleosaurus*. The free surface of the centrum is smooth. The neural arch articulates with the whole length of the centrum by the neurapophysial surfaces of the form shown in fig. 5, *np*. The neural canal (ib., *n*) slightly widens behind. Two vertical, venous canals open into the neural one. Fig. 6 is the side-view of a cervical centrum from the Purbeck beds, having the general proportions of those of *Goniopholis*, but differing in the smaller size of the parapophysis. Figs. 7—9 are views of the centrum of a dorsal vertebra of the Purbeck *Goniopholis*, fig. 9 showing the texture as displayed by a vertical longitudinal section. It is compact or minutely cancellous throughout; whereas the centra in the *Teleosaurus* exhibit a more open, reticulate texture, with a cavity near the centre; this cavity is still larger in *Poikilopleuron*.

One of the posterior caudal vertebræ of the Cuckfield specimen, after the subsidence of the diapophyses and the great reduction of the zygapophyses, shows the spinous process rising from the hinder part of the neural arch, as at *g*, Pl. III.

The coracoid (ib., *h*) differs from that of the existing Crocodiles in its greater relative breadth at the neck or part marked *h*, in the more gradual and minor expansion of its mesial end, and in the more regular convexity of its scapular border. It exhibits the same perforation near this border as in the modern Crocodiles.

The humerus associated with the remains of *Goniopholis* from the Wealden of Cuckfield has the usual Crocodilian form and sigmoid flexure. Compared with one from a *Crocodylus biporcatus*, with the same-sized cervical vertebræ, it is a somewhat thicker and stronger bone. It has a broader and thicker ulnar tuberosity, and the angle at which the process is bent down upon the shaft is less marked, more rounded off. The radial crest is a triangular, compressed ridge, but is not produced beyond four lines from the surface of the shaft; the distal part of the bone is proportionately thicker antero-posteriorly than in the modern Crocodiles, and the longitudinal, irregular ridges

at the margin of the articular surface are stronger; there is a similar ridge above the inner condyle.

The femur of the *Goniopholis* (Pl. III, *o*) is relatively longer, and is less bent than in the existing Gavial or Crocodile. The tibia (*m* and *n*, the latter bone presenting its narrower side to view) is also both longer and thicker.

Dermal Scutes.

In the slab of Wealden stone from Cuckfield, containing the parts of the dislocated skeleton shown in Pl. III, there were imbedded, not only the long, quadrate, toothed scutes (*a*, *b*), like those in the Purbeck slab (Pl. IV, fig. 1), but a second form of scute (ib., *d*) of which no examples had been preserved in the Purbeck specimen. Of this second form detached specimens were obtained from the same formation and locality, of which one is figured in Pl. IV, figs. 2, 3, 4. These scutes are hexagonal, marked, as in the toothed kind, on the outer surface, by hemispheric, circular or subcircular pits, and on the inside by fine, linear, decussating lines, on an otherwise smooth and plane surface. They have no articulating process, but have a strongly marked sutural surface on the thick margin (ib., fig. 3), showing them to have been united together, like the neural and costal plates of the carapace, and like the elements of the plastron, in the *Terrapene* and *Tortoise*. The section (fig. 4) shows the depth of the external pits, the texture of the scute, and its level and even under surface, *d*.

From the association of hexagonal sutural scutes with the quadrate, oblong, toothed scutes in the specimen (Pl. III), it can hardly be doubted that they formed part of the same exo-skeleton, and are probably from the ventral region. Some slightly modified shapes are shown in the scutes marked *f* in Pl. III.

In the sixth part of the sixth volume of the 'Palæontographica' of H. v. Meyer, the author has described and figured part of the dermal skeleton of what he believes to have been a Saurian reptile, consisting of bony plates, for the most part hexagonal, and united by marginal sutures. These plates, however, do not present the uniformly pitted character of the external surface, as in *Goniopholis*, but here and there in the series they show a few irregular, large depressions; the more constant markings are smaller, apparently vascular foramina, and linear, usually radiated, impressions, in character more like the markings of the dermal ossifications of the Labyrinthodont Reptiles. The specimen described is from the "Dachsteinkalk," under the Winkelmaas Alpe, near Runpalding, in Bavaria, and it is referred to the *Psephoderma Alpinum*.

Species—*Goniopholis simus*, Ow. Plate V.

This species is founded upon the entire skull, *minus* the lower jaw, imbedded in the limestone of the Swanage quarry, of which skull a reduced view of the upper surface is given in Pl. V, fig. 1; and of so much of the under surface (ib., fig. 2) as could be brought to light by exploratory operation on that part of the imbedding slab.

The skull in its general shape corresponds with the broad-faced species of the Procœlian Crocodiles;¹ and in the festooned contour of the alveolar borders, with those having teeth of unequal size, and with a crown of mainly the proportions of the teeth in the present Amphicœlian genus.

The conclusion conveyed by the latter expression is not, indeed, based upon the discovery of vertebræ in such contiguity with the present skull as to support an inference as to their having formed part of the same skeleton; but it is a probable one from the association of such vertebræ with the foregoing nearly allied species of *Goniopholis*; and such probability is strengthened by the nature of the cranial modifications by which the skull under review differs from those of the Procœlian species most nearly resembling it in shape.

The temporal vacuities (ib., fig. 1, *t*) are relatively larger than in *Crocodylus* proper, or broad-faced Procœlians, and are subquadrate in form. The palatonaris (ib., fig. 2, *n*) is not only larger, but is more advanced in position, so as to come wholly into view on the bony palate, and on the same plane therewith; and here, moreover, they receive for completion of their anterior contour, the hinder ends of the proper palatine bones (ib., ib. 20), three fourths only of the border being contributed by the pterygoids (ib., ib., 24). The Eustachian aperture (ib., ib., *e*) is likewise on the palatal, not the occipital, plane.²

In these characters is manifested the nearer affinity of the Purbeck Crocodilian to the Amphicœlian Teleosaurs³ than any Tertiary or modern genus presents.

The following are amongst the modifications of minor import in the skull of the present species of *Goniopholis*. The external nostril (Pl. V, fig. 1, *n*), horizontal in position, is more nearly terminal than in modern Crocodiles, or than in *Goniopholis crassidens* (Pl. I, fig. 2, *n*). It is formed by the premaxillaries exclusively; the nasal bones terminating about an inch behind the nostril. In Procœlian Crocodiles a graduated series of developments of the nasal bones may be traced. They may be short, as in *Gavialis gangeticus*, or extend to near the nostril, as in *Crocodylus cataphractus*, rather nearer in *Crocodylus intermedius*, still nearer in *Crocodylus Hastingsiæ*, be produced close

¹ Cuvier, 'Ossem. Foss.,' tom. cit.

² 'Phil. Trans.,' MDCCCL, pl. xi, fig. 1 *e*.

³ Ib., p. 522.

to the aperture as in *Crocodylus champsöides*, penetrate a short way into the aperture, as in *Crocodylus suchus*, or, by continuous ossification of the septum in old individuals of *Crocodylus niger* and *Alligator lucius*, extend seemingly across the nostril. These characters, barely of specific value, have been used in the fabrication of genera of existing Crocodiles and Alligators,¹ in all of which the orbits are larger than the upper temporal apertures.

In *Goniopholis simus* the orbits (Pl. V, fig. 1, *o*) are rather smaller than the apertures (ib., ib., *t*).

Each pterygoid (fig. 2, 24,) articulating by a crenate suture with the narrow hind end of the palatine (ib., 20), which diverges from its fellow to form the fore part of the palatonaris, loses vertical thickness and gains in breadth as it extends backward. It there articulates by a tract of an inch in length with the basisphenoid. The Eustachian canal (ib., *e*) opens at the midspace between the basisphenoid and basioccipital. The latter arches down in advance of the condyle, and the venous foramen is conspicuous on this tract.

As the pterygoids are relatively less than in the Procœlians, so the palatines are relatively larger, especially in anterior breadth. After contributing their share to the palatonaris, they come into contact and the medial suture is continued forward to an extent of 3 inches 5 lines. The anterior breadth of the pair is 3 inches 4 lines. The medial suture of the palatal plates of the maxillaries was traced forward two inches or more in advance of the palatines, and laterally the plates were exposed to the same breadth as the palatines proper. The palato-maxillary suture, 20'—21', is strongly sigmoid, describing as it leaves the midline a convexity forward and then a concavity. It was not thought expedient to endanger the unique specimen by further excavation in reference to the comparatively unimportant premaxillo-maxillary palatal suture.

The bony palate, as far as it was exposed, is smooth; the upper surface of the skull is rugose and pitted. The pits are circular or subcircular, from 1 to $2\frac{1}{2}$ lines in diameter, situated chiefly on the swollen sides of the maxillaries and on the cranial part of the skull, including the expanded upper and outer surface of the squamosals; and the tympanic pedicles are smooth, and terminate in the usual transversely extended concavo-convex articular surface.

The tooth called "anterior canine" is preserved, somewhat mutilated, in each premaxillary. Sockets of smaller premaxillary teeth are faintly traceable. The tooth termed "posterior canine" projects from the anterior part of the outswollen and convex border of the maxillary. From portions or traces of the other teeth or sockets I estimate that there were from sixteen to eighteen teeth on each side of the upper jaw. In the largest and least mutilated crowns of these teeth the dental characters of the genus *Goniopholis* are shown.

In the 'Catalogue of the Osteological Series, Mus. Coll. Surgeons,' 4to, 1853, p. 164, is described the specimen No. 752, as "The skull of a Crocodile from Bengal,

¹ 'Trans. Zool. Soc.,' vol. vi, p. 125.

wanting the lower jaw, of a species (*Crocodylus palustris*?) which is frequently found inhabiting the larger ponds. It differs from the *Cr. biporcatus* of the Ganges in having shorter maxillary and premaxillary bones in proportion to its length, and in having much less developed prefrontal ridges; the palatal suture between the maxillary and premaxillary bones is transverse, not curved. The anterior extremities of the palatine bones are narrower and more pointed. The number of alveoli is—premaxillary 5—5, maxillary 14—14.”

The doubt indicated (?) arose from the inadequate characterisation by Lesson, of the species described by him in the ‘Zoologie’ of the ‘Voyage aux Indes Orientales de Bélanger;’ but there is no reference of the specimen, No. 752, to the *Crocodylus rhombifer*, as is affirmed by the author of the “Synopsis of the Species of Recent Crocodiles,” ‘Trans. Zool. Soc.,’ vol. vi, p. 140. I did not regard my doubt as justifying the sinking of Lesson’s “*palustris*” into a synonym, and of imposing a new specific, much less generic name. But the osteological character of the palatal region of the skull, pointed out in my ‘Catalogue,’ appears to be the chief of those relied upon by the author of that ‘Synopsis’ for his genus *Bombifrons*, of which the first character is:—“The premaxillary suture straight, or rather convex forwards” (loc. cit., p. 139). The other characters are not of specific value.

The sutures of the premaxillary bones, I may remark, are of three kinds; one is medial and unites the pair; it is the “interpremaxillary suture:” the second is lateral, uniting the outer or dental plate of the premaxillary with that of the maxillary; it is the “premaxillo-maxillary suture:” the third is transverse, more or less, and unites the palatal plate of the premaxillary with that of the maxillary; it is the “premaxillo-maxillary palatal suture.” Its modifications, added to other differences, when determined to be constant, may aid in differentiating the species of *Crocodylus* proper, of *Alligator*, and of *Gavialis*.¹

The convenience of these three genera of Procœlian *Crocodylia*, although they agree in palatonarial and vertebral characters, will probably ensure their retention; but *Tomistoma*, *Oopholis*, *Halcrosia*, *Palæosuchus*, *Rhynchosuchus*, *Ramphostoma*, *Mecistops*, *Bombifrons*, *Palinia*, *Molinia*, *Caiman*, *Jacare*, &c., into which they have been subdivided, exemplify the evil of “encumbering the science with a multitude of names” (loc. cit.,

¹ Prof. Marsh, in his ‘Introduction and Succession of Vertebrate Life in America,’ 8vo, 1877, writes (p. 21):

“The beds of the Rocky-Mountain Wealden have just furnished us with a genuine “missing link,” a Saurian (*Diplosaurus*) with essentially the skull and teeth of a modern Crocodile, and the vertebræ of its predecessor from the Trias.”

When the cranial characters of this Crocodilian are made known it will be of moment to compare the temporal apertures on the upper surface and the palato-narial apertures on the under surface of the skull. When the dental characters of the same fossil are described and figured we may be able to determine whether they are those of the broad-faced procœlian Crocodiles and Alligators or those of *Goniopholis*.

p. 128),—an evil which, if the “names” do not represent “generic distinctions,” cannot be laid to the charge of the “Palæontologist.”

At least, the “small fragments of the fossil skeleton” (ib., p. 128) on which the genus *Goniopholis* was originally founded have subsequently been proved, by acquisition of other parts, to have indicated accurately that well-marked and interesting addition to the recorded modifications of the Crocodilian type. Those of the vertebral and cranial structures have, indeed, proved to be not only of generic, but of family value.

Genus—*PETROSUCHUS*, *Owen*.¹

Species—*Petrosuchus levidens*. Plate VI.

This genus and species of Crocodile is founded on the portion of skull and mandible, figured in Plate VI. The skull is imbedded in the same limestone of the Middle Purbecks, now quarried at Swanage. It was discovered in a block with the upper surface (ib., fig. 1) exposed. This surface is partially weathered, but shows here and there a faintly wrinkled natural sculpturing. The upper temporal apertures are larger than the orbits. In front of these the skull contracts more rapidly than in *Goniopholis*, and presents, as far as it is preserved, a slender form of face approaching to the proportions of that in the modern *Crocodylus cataphractus*,² and in the Tertiary *Crocodylus champsoïdes*,³ but the more rapid contraction in front of the orbits is gavial-like, and there are other characters indicative of a nearer affinity than in *Goniopholis* to the Teleosaurian group. This affinity is decisively marked by the larger relative size and more advanced position of the palatonaris (ib., fig. 2, *n*), into the formation of which the diverging hind ends of the palatines (ib., fig. 2, 20) enter in a larger proportion than in *Goniopholis*. The basisphenoid (ib., ib., 5) is more produced, and the pterygoid (ib., ib., 24) contracts a more extensive sutural union therewith. Each palatine bone (ib., ib., 20), where they diverge at the palatonaris, shows a protuberance on its under surface. The Eustachian outlet is seen at *e*.

The portion of the left mandibular ramus (Pl. VI, fig. 3) includes the dentary element (32), nine inches in length, with portions of the angular (30) and surangular (29); that of the angular including six inches of its extent. Of this element two inches extend forward in advance of the hindmost point of the dentary; and, guided by the proportions of the *Crocodylus champsoïdes*, I estimate the total length of the

¹ Gr. πέτρος, rock, and Σόχυν, an Egyptian name of the Crocodile.

² Cuvier, ‘Ossem. Foss.’ 4to, tom. v, part ii, pl. v, figs. 1 and 2; Gray, ‘Trans. Zool. Soc.’ vol. vi, pl. xxxii, fig. 2.

³ Pal. vol. for the year 1849, ‘Fossil Reptilia of the London Clay,’ t. iii.

mandible of *Petrosuchus levidens* to be 16 inches, or thereabouts, indicating that from four to five inches are wanting at the fore part of the subject of fig. 1.

The vertical extent of the ramus behind the mandibular vacuity (ib., fig. 3, *v*) is 1 inch 9 lines; the vacuity itself is 1 inch 6 lines in long diameter, 6 lines in short diameter; its long axis is nearly parallel with that of the ramus. The lower, like the upper jaw, appears to have been long exposed on its imbedding block of stone. Little of the outer layer of the bone is preserved, and this is limited to parts of the angular and surangular. It here shows a more decided reticulate sculpture, the meshes being in the form of subcircular pits of from 1 to 2 lines in diameter.

The vertical breadth of the dentary at the terminal point of the angular is 1 inch 3 lines; it loses, as usual, in this diameter as it advances, but irregularly, owing to a gentle undulation of the alveolar border. This is convex where it supports the anterior group of teeth opposed to the premaxillary and foremost upper canine teeth; it is then slightly concave to the mid-third part, where the border is more feebly convex; beyond this, after a feeble concavity, it gradually rises to the surangular piece (29).

Of the foremost group of teeth seven are preserved; the third counting from the foremost being the longest and broadest, with the crown curving upward and a little backward; the length of this tooth is 1 inch 4 lines, its extreme breadth is 3 lines, about half of the total length forms the exerted crown, but the point is not entire. The first and fifth of this series are the next in size, but do not exceed an inch in length, the intermediate teeth are smaller; two or three sockets of still smaller teeth may be traced in the concave part of the border. In the following convex part, seven teeth are preserved, with shorter and relatively thicker crowns than in the foremost group; but none of them showing the robust proportions of the teeth of *Goniopholis*. Behind this group the indications of teeth and sockets are faint. I estimate the number of teeth in the present ramus at about twenty; which is the number in the mandibular ramus of *Crocodylus champsoides*: a margin of two or three more or less being allowed for a perpetually changing set of teeth.

The inequality of the size of the teeth and concomitant festooned course of their alveolar series is Crocodilian, as contrasted with the Gavialian and Teleosaurian types. But the temporal and palatonarial openings indicate the generic distinction of *Petrosuchus*, with its transitional character between the Teleosaurian and Tertiary Crocodiles.

Portions of dermal scutes, with the pitting as on the mandible, but with wider intervals, are preserved on the slab in which the above-described fossil is imbedded.

Genus—SUCHOSAURUS, *Owen*.¹ SUCHOSAURUS CULTRIDENS² (Pl. IV, figs. 5—8).

In the Wealden formations have been found detached teeth and vertebræ, indicating the existence, at that period, of a large Amphicœlian Crocodile specifically and generically distinct from both *Goniopholis* and *Petrosuchus*; for, since the discovery of associated bones and teeth of the former genus has made us acquainted with its vertebral characters, an exhaustive analysis of the other reptilian fossils of the Wealden series leave only the form of Saurian tooth, Pl. IV, figs. 5 and 6, wherewith to associate the equally peculiar form of Saurian vertebra, *ib.*, figs. 7, 8. This vertebra is readily distinguishable, by the length of the centrum and the compressed wedge-shaped character of its middle part, from all other known Saurian (Dinosaurian or Crocodilian) vertebræ of the Wealden period. The specimen (No. $\frac{198}{2138}$, Mantellian Collection of Wealden fossils in the British Museum) is the centrum of a dorsal vertebra, with both articular extremities slightly and equally concave; though narrower at the middle than at the ends, it is more uniformly compressed than in other Crocodilian vertebræ, the sides converging to an inferior obtuse ridge, which is very slightly concave in the antero-posterior direction. The sides are not flat in the vertical direction nor slightly concave, as in many of the *Iguanodon*'s vertebræ, to which the present form approximates; but are gently convex, so that a pencil laid vertically upon the sides touches it only by its middle. A more decided difference between the present Crocodilian vertebræ and those of the *Iguanodon* is, that the former are longer in proportion to their height and depth. The external surface at the middle of the body of the vertebra is very finely striated, so as to present a silky appearance; near the margins it is sculptured by coarse, longitudinal grooves and ridges.

The base of the neurapophysis which, when anchylosed, leaves an evident trace of the suture, is nearly equal in length with the body of the vertebra; it does not wholly include the neural canal, but leaves the impression of the lower third of that canal upon the upper surface of the centrum. On the outside of the neurapophysis are two slightly developed, broad, obtuse ridges, converging towards each other from the outer side of each angle or end of the base of neurapophysis; the ridge corresponding with the posterior of these in the *Iguanodon*'s vertebra rises more vertically, and is in higher relief. The neurapophysial suture slightly undulates in its horizontal course, and rises in the middle instead of descending upon the centrum, as in the *Plesiosaurs*.

The present vertebra is alluded to at p. 70, and figured at pl. ix, fig. 11, of Mantell's

¹ 'Report,' *ut supra*, p. 67 (Gr. Σούχος, an Egyptian name of the Crocodile, and σαῦρος, lizard).

² *Ib.*, *ib.*

'Illustrations of the Geology of Sussex,' 1827, as a lumbar vertebra of the *Megalosaurus*. But in the 'Geology of the South-east of England,' the same author, speaking of this vertebra, observes, "It cannot, I now think, be separated from those figured in the same plate as belonging to a Crocodile;" p. 297, *note*. The body of the Megalosaurian vertebra has a pretty deep, longitudinal depression between the neurapophysial suture, wanting in the Tilgate vertebra here described. This, however, is not the only distinction; below the depression the centrum of the Megalosaur swells out, and is as convex below as it is laterally in the transverse section, so that the outline of a transverse section would describe five sixths of a circle; a similar section of the vertebra of *Suchosaurus* would be triangular, with the apex rounded off. The Megalosaurian vertebra is more contracted at the middle, and swells out near the articular ends, surrounding those articulations with a thick convex border; in *Suchosaurus* the lateral meet the marginal surfaces at a somewhat acute angle; but the silky striated surface of the Suchosaurian vertebra, and the smooth and polished surface of the Megalosaurian one, would effectually serve to distinguish even fragments from the middle of the body of each.

The following are dimensions of the vertebra of the large Wealden Crocodilian above described:

	No. 138.	
	Inches.	Lines.
Antero-posterior diameter of the body	3	10
Vertical diameter of its articular end	3	2
Transverse diameter of its articular end	2	9
Transverse diameter of the middle of the body	2	0

The fossil teeth from the Wealden (Pl. IV, figs. 5, 6), which I provisionally associate with the foregoing vertebra, approach by their more slender and acuminate form to the character of those of the Gavial, but differ from the teeth of any of the recent species of that genus of Crocodilians, as well as from those of the long and slender-snouted extinct genera (*Teleosaurus*, *Steneosaurus*, &c.). The crown is laterally compressed, subincurved, with two opposite trenchant edges, one forming the concave, the other the convex, outline of the tooth. In the Gavial the flattening of the crown and the situation of the trenchant edges are the reverse, the compression being from before backwards, and the edges being lateral.¹ The tooth of the Suchosaur thus resembles in form that of the Megalosaur, and perhaps still more those of the Argenton Crocodile; but I have not observed any specimens of the Wealden Crocodilian teeth in which the edges of the crown were serrated, as in both the reptiles just cited. The teeth of the Suchosaur also present a character which does not exist in the teeth of the Megalosaur, and is not

¹ The tooth attributed by M. Deslongchamps ('Mémoires de la Société Linnéenne de Normandie,' vol. vi, p. 39) to the *Poikilopleuron* agrees in form with those of the Gavial, and differs in the characters cited in the text from those of the *Suchosaurus*.

attributed by Cuvier¹ to those of the *Crocodile d'Argenton*. The sides of the crown are traversed by a few longitudinal, parallel ridges, with regular intervals of about one line, in a crown of a tooth one inch and a half in length; these ridges subside before they reach the apex of the tooth, and more rapidly at the convex than at the concave side of the crown.

Hitherto these teeth have not been found so associated with any part of the skeleton of the same species as to yield unequivocally further characters of the present extinct Crocodilian. From the above-mentioned well-marked differences between these teeth and those of all other known species, I regarded the extinct Crocodile in my 'Report on British Fossil Reptiles' as forming the type of a distinct genus and species, and proposed for it the term *Suchosaurus cultridens*. It indicates a nearer affinity or transition to the Dinosaurian order than does any of the mesozoic *Crocodylia*, known by their cranial as well as by their dental, vertebral, and dermal characters.

Of those species so recognised, including the Purbeck and Wealden kinds now added, the following are common characters. A greater development, than in Tertiary Crocodiles, of the dermal bony armour, which consists, without exception, of both dorsal and ventral scutes, the scutes in each series well connected with each other, and in *Goniopholis* exceptionally so.

A less development of the osseous surface for the origin of the muscles of the mandible indicated at the upper surface of the cranium by the larger 'temporal vacuities,' and at the under surface by the smaller pterygoid plates. Horizontal plane, larger size, advanced position and palato-ptyergoid formation of the palatonares.

Amphicœlian vertebræ.

These common characters of mesozoic *Crocodylia* suggest considerations of their relation to the prey of such *Crocodylia* and also to the coexistent marine reptiles of which those *Crocodylia* themselves became the prey.

Similarly, if the common characters of the tertiary and existing *Crocodylia* be summed up they become suggestive of analogous considerations.

A minor development than in mesozoic crocodiles of the dermal bony armour, consisting, with few exceptions, of the dorsal scutes only, and these relatively smaller, thinner, and less closely knitted together, may relate to the absence of the Mosasaurs, Pliosaurus, Polyptychodonts, &c., against the assaults of which the contemporary crocodiles of those Saurians required a better defensive armour.

The greater development of the osseous surface for the origin of the muscles of the mandible, indicated at the upper surface of the cranium by the smaller, or obliterated, 'temporal vacuities,' and, at the under surface, by the more expanded alæ of the pterygoids, accords with the stronger jaws and dentition, as an adaptative to seize and subdue a stronger and more resisting kind of prey than that on which the mesozoic crocodiles habitually fed.

¹ Cuvier, 'Ossem. Fossiles,' 8vo. tom. ix, p. 331.

The oblique plane, posterior position, small size, and exclusively pterygoid formation of the palatonares, together with the proœlian vertebræ, lead one to think of the contemporary coming in, with the neozoic crocodiles, of active, warm-blooded, air-breathing mammals.

But the considerations suggested by such correlations require the wholesome sifting of discussion; and I, therefore, propose to reserve them for a communication to the Geological Society of London.

I will only add that any additional evidences of the cranial characters of Purbeck Crocodiles will be gratefully received.

PLATE I.

Goniopholis crassidens.

FIG.

1. Premaxillary extremity of skull, palatal surface.
2. Premaxillary extremity of skull, outer surface.
3. Crown of large maxillary tooth.
4. Crown of small maxillary tooth.
5. Symphysial extremity and part of ramus of mandible, upper or oral surface.
6. Crown of small mandibular tooth.
7. Two hindmost mandibular teeth.
8. Large and small mandibular teeth from near the middle of the series.

The subjects of figs. 1—4 are from the Wealden of Cuckfield.

The subjects of figs. 5—8 are from the Limestone Series of the Middle Purbeck.

All the figures are of the nat. size.



From nat. on stone by J. Erxleben.

W. West & Co. imp.

PLATE II.

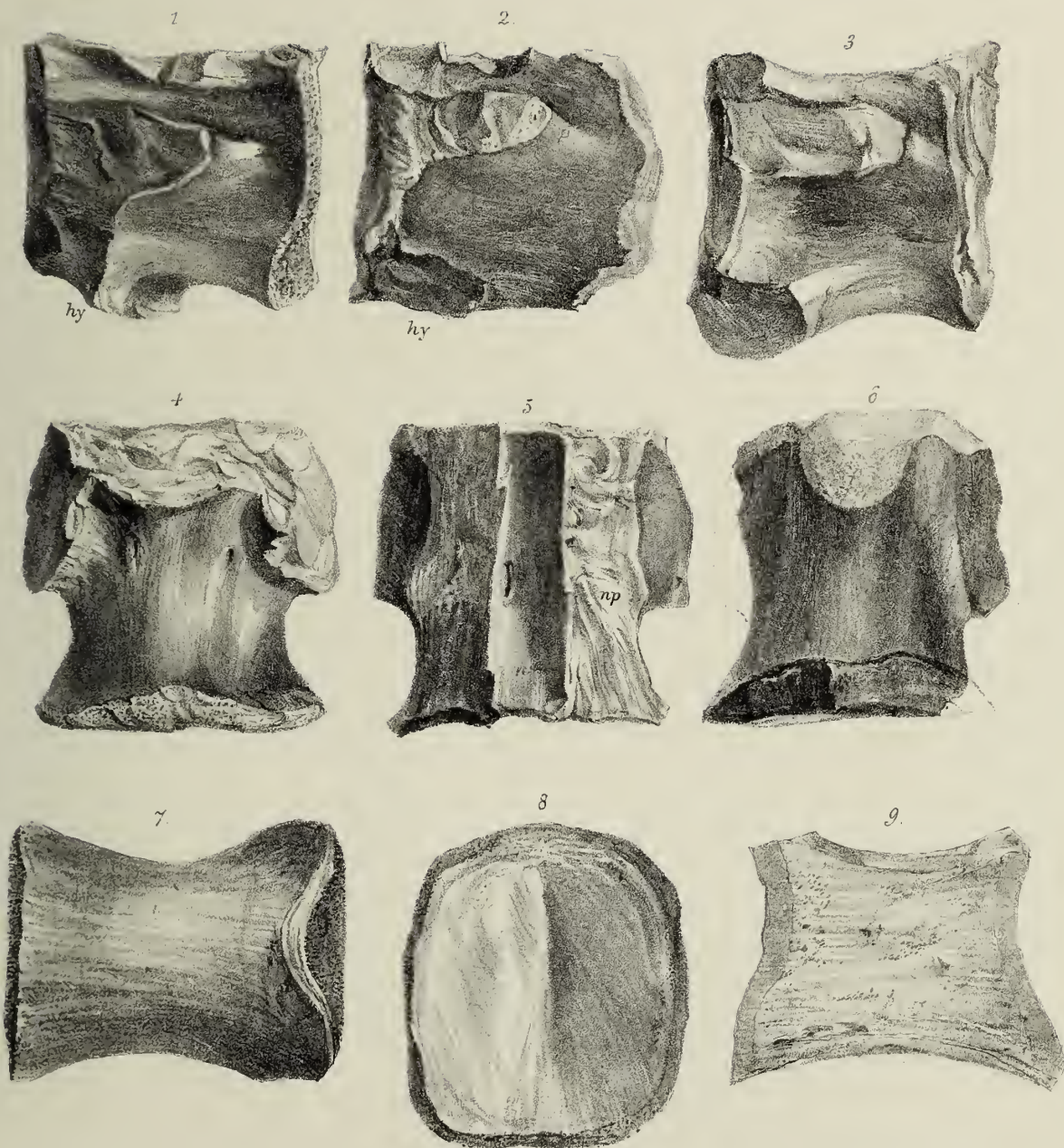
Goniopholis crassidens.

FIG.

1. Side view of centrum of third cervical vertebra.
2. Side view of centrum of fourth cervical vertebra.
3. Side view of centrum of fifth cervical vertebra.
4. Under view of centrum of third cervical vertebra.
5. Upper view of the same.
6. Side view of centrum of sixth cervical vertebra.
7. Under view of centrum of dorsal vertebra.
8. Front view of centrum of dorsal vertebra.
9. Vertical longitudinal section of centrum of dorsal vertebra.

The subjects of figs. 1—6 are from the Wealden of Cuckfield.

The subjects of figs. 7—9 are from the Limestone Series of the Middle Purbeck.



From nat on stone by J. Erdeben.

W. West & Co. imp.

PLATE III.

Goniopholis crassidens.

A slab of Wealden Stone with bones, teeth, and scutes : two thirds nat. size.

From the Wealden of Cuckfield.



PLATE IV.

Goniopholis crassidens.

FIG.

1. Dorsal scute, outer surface.
2. Ventral scute, outer surface.
3. Sutural margin of ventral scute.
4. Section of ventral scute.

Suchosaurus cultridens.

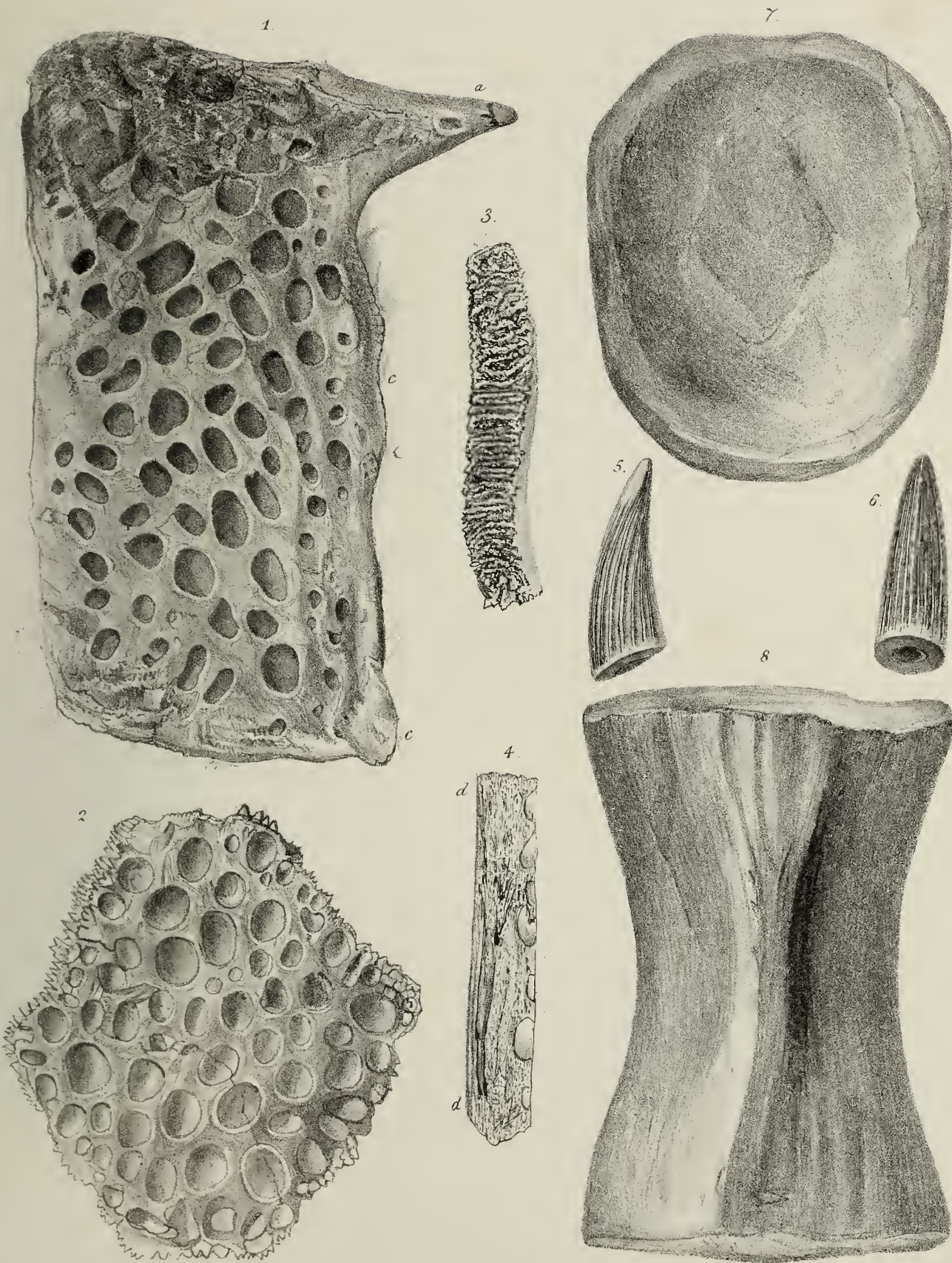
5. Side view of crown of tooth.
6. Hind view of crown of tooth.
7. Hind articular surface of centrum of dorsal vertebra.
8. Under surface of centrum of dorsal vertebra.

The subject of fig. 1 is from the Limestone Series of the Middle Purbeck.

The subject of figs. 2—4 is from the Wealden of Cuckfield.

The subjects of figs. 5—8 are from the Wealden of Tilgate.

All the figures are of the natural size.



On stone by J. Frixleben.

W. West & Co. n.p.

1-4. GONIOPHOLIS
5-8. SUCHOSAURUS

CRASSIDENS.
CULTRIDENS.

PLATE V.

Goniopholis simus.

FIG.

1. Upper surface of skull.
2. Portion of the palatal surface of skull.
3. Portion of the left alveolar border and teeth of upper jaw.
4. The largest (2nd canine) of the upper series of teeth.

From the Limestone Series of the Middle Purbeck.

Figs. 1—3 : half nat. size ; Fig. 4 : nat. size.



From nat. os. Stone by J. Erxleben

W. West & Co. imp.

GONIOPHOLIS SIMUS.

PLATE VI.

Petrosuchus levidens.

FIG.

1. Portion of skull, upper surface.
2. Portion of skull, palatal surface.
3. Portion of right ramus of mandible.

From the Limestone Series of the Middle Purbeck.

All the figures are of the nat. size.



3.

1.

2.

